THE SALT RIVER BASIN

The Salt River Basin is the most centrally located basin in Kentucky. It extends 70 miles into Kentucky through rolling farmland and is as wide as it is long. The water quality in this basin is influenced by dry season low flow, excessive erosion, and by the largest population center in Kentucky, Louisville, being partly located within this basin.

The first section of this report will provide a basin description covering both physical and population characteristics. The second section will analyze the water quality considering its causes and effects.

I. Basin Description

A. Geography

The Salt River flows into the Ohio River 352 miles above the mouth of of the Ohio River. The city of West Point at the mouth of the Salt River is 23 miles downstream of Louisville.

The Salt River drains 2,932 square miles of rolling farmland in central Kentucky. This drainage basin contains all or part of the following counties: Bullitt, Jefferson, Oldham, Henry, Shelby, Anderson, Mercer, Boyle, Casey, Marion, Taylor, Larue, Hardin, Nelson, Washington, and Spencer. In the Salt River Basin, there are five sub-basins with an area over 200 square miles. Beech Fork has approximately 750 square miles, Brashears Creek, Floyds Fork, and the Chaplin River all drain about 270 square miles, and the Rolling Fork drains 145 square miles.

B. Topography

The basin lies wholly within the Bluegrass Region which has a hilly to gently rolling topography from east to west with an area of "Knobs" in the northwestern section around the Fort Knox military reservation. This basin is drained by three major streams. These are the Salt River, the Rolling Fork and Beach Fork. The slope of the Salt River is 5.0 feet per mile (ft./mi.).

The slope of Rolling Fork averages 6 ft./mi. and the slope of the Beach Fork is 4 ft./mi.

The average slope of the major tributaries are Brashears Creek, 6 ft./mi., Chaplin River, 6.5 ft./mi., and Floyds Fork, 7 ft./mi. The elevation in this basin varies from 380 to 1,140 feet above sea level.

Slope, up to ten ft./mi., has a direct effect on the reaeration of a stream. With slopes from 0-2 ft./mi., the reaeration is low. Slopes from 3-6 ft./mi. give a medium reaeration while slopes of 7-10 ft./mi. give a high reaeration. These stream slopes provide moderate to good reaeration of the streams.

C. Geology

The base parent materials in this basin are limestone and dolomite, slate and shale. The limestone and dolomite through solution impart hardness to water and give rise to a bicarbonate type of hardness.

The groundwater availability in the Salt River Basin is low. Wells which yeild 100 gallons per minute (g.p.m.) are rare, the majority of the wells produce 50 g.p.m. or less. This limited availability of groundwater and the "Knob" topography are factors causing extremely low flow during the dry months of the year.

D. Hydrology

The stream flow in the Salt River Basin was selected at four gauging stations. The stations are (1) at Boston on the Rolling Fork, (2) at Bardstown on the Beach Fork, (3) Fisherville on Floyds Fork, and (4) at Shepherdsville on the Salt River.

For these stations, the period of record, drainage area, average flow, maximum flow, minimum flow, and the seven day ten year low flows as follows:

Surface Flow Records for the Salt River Basin

Station	Period of Record	Drainage Area	Average Flow	Maximum Flow	Minimum Flow	7 day 10 yr. low flow
Salt River at Shepherdsville, Kentucky	36 yr.	1,197 sq. mi.	1,516 cfs, 1.3 cfs* / sq. mi.	78,200 cfs, 65 cfs / sq. mi.	0 cfs, 0 cfs / sq. mi.	0.6 cfs**
Floyds Fork of Salt River at Fisherville, Kentucky	30 yr.	138 sq. mi.	168 cfs, 1.2 cfs / sq. mi.	28,500 cfs, 206 cfs / sq. mi.	0 cfs, 0 cfs / sq. mi.	0 cfs
Rolling Fork of Salt River at Boston, Kentucky	36 yr.	1,299 sq. mi.	1,705 cfs, 1.3 cfs / sq. mi.	50,500 cfs, 38.9 cfs / sq. mi.	0.4 cfs, 0 cfs / sq. mi.	1.7 cfs
Beech Fork of Salt River at Bardstown, Kentucky	35 yr.	669 sq. mi.	894 cfs, 1.3 cfs / sq. mi.	33,900 cfs, 50.7 cfs / sq. mi.	0 cfs, 0 cfs / sq. mi.	0.2 cfs

* Cubic Feet Per Second

** Extrapolated

NOTE: Data is taken from "Surface Water Records in Kentucky" by the United States Geological Survey. The 7 day 10 year low flow was taken from the waste load allocation produced as a component of the 303e River Basin Continuing Planning Process.

Presently, there are no major impoundages in the Salt River to provide for low flow augmentation. The Corps of Engineers has been authorized to construct the Taylorsville Reservoir which will provide low flow augmentation of 60 cfs.

The Salt River at Shepherdsville is very flashy as shown in comparison of the average flow to the maximum. The ratio of average to maximum is 52. Most of the streams at some time of the year have zero flow. The low flow contributes to problems with organic waste loads and sediment.

E. Population

There are 507,232 people in this basin (see Table G-2). The SMSA of Louisville accounts for sixty-four per cent of the population. This portion of Louisville (Jefferson County) is located in the Pond Creek and Floyds Fork Sub-basins. Louisville has completed a 201 Facility Plan and is developing a 208 area wide waste water management plan. As the 201 plan is implemented, the effect of the 250 discharge into Pond Creek and Floyds Fork will be eliminated with the initial interceptors planned for completion in 1977 and

all discharges eliminated by 1985. Roughly seven per cent of the population is located in Hardin County at Fort Knox. The rest of the population is located in small towns and rural populaton throughout the basin. There are eight towns (13,679 people who do not have sewers and these represent possible sources of pollution from septic tanks and other inadequate treatment devices.

II. Basin Water Quality

In this section of the report the actual water quality in the Salt River Basin will be examined, along with some of the major factors involved. The major water uses in the basin are also presented.

A. A Description of Sampling Stations

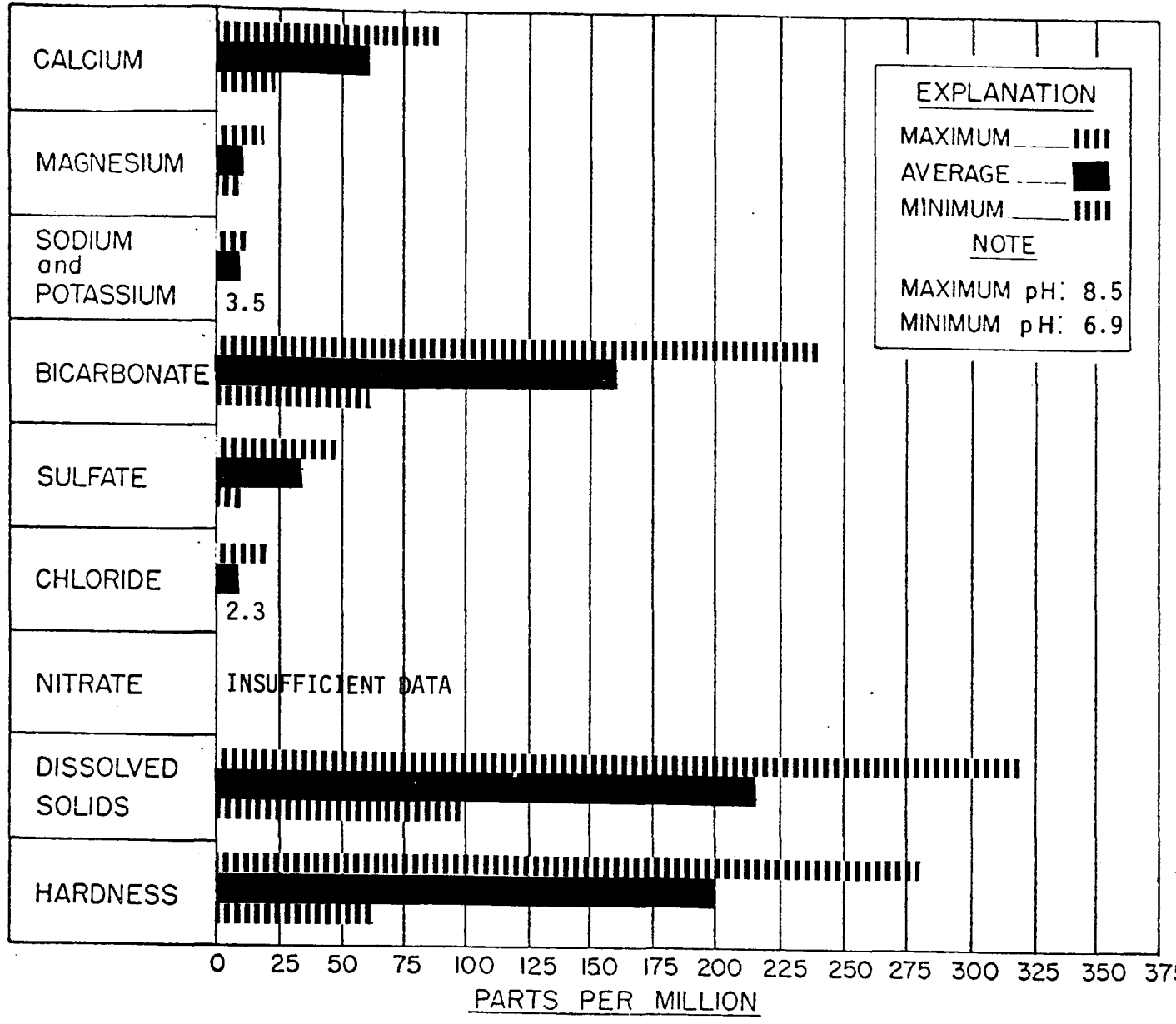
There is only one station in this basin with sufficient data to describe water quality. It is located at Shepherdsville, Kentucky, 23 miles upstream from the mouth of the Salt River with drainage basin area of 1,200 sq. mi. or 41 per cent of the basin.

This station was chosen due to the location and length of record. It is believed that the water quality measured at this station is representative of the water quality in most of the surface streams in the basin.

B. General Chemical Water Quality

The chemical composition of water is best defined by grouping dissolved elements which compose the total dissolved solids. By examining the relationships of groups of chemicals, the type of water whether hard or soft, salty, acid or high in sulfates reflects the mix of surface and groundwater. The chemical characteristics of a stream when viewed over a long period of time is primarily from surface water. The type of rock formation and soils which the surface water contacts causes this predominate chemical characteristic. The contribution of groundwater, which is generally higher in dissolved solids than surface water, can be shown by selecting the low flow period for data analyses. The general character of waters in Kentucky is one of moderate hardness caused by calcium and magnesium salts.

In the Salt River Basin, there is a high bicarbonate ion content giving the water a high bicarbonate hardness. This is due to the limestone bedrock of the area. In all other respects the quality of the surface water is considered to be excellent. The graph of water quality indicates the variation from the



MAXIMUM, AVERAGE, and MINIMUM concentrations of dissolved constituents, Salt River at Shepherdsville

Period of Record: 11-65 to 11-74

FIGURE G-1

average is low and, therefore, uniformity of water quality allows stable operation of water supply treatment plant and industry water usage is enhanced.

C. Trace Chemical Water Quality

Trace elements (under 5 mg/l) are separated from the general chemical background of this report because of their influence on human health. Generally, these materials are "heavy" metals, which in sufficient concentrations have a toxic or otherwise adverse effect on human and animal or plant life. Levels for many of these elements have been established for years in the Drinking Water Standards and more recently through the State-Federal Water Quality Standards.

Trace chemicals in the surface water of the Salt River Basin in Kentucky were measured as being within Kentucky-Federal Water Quality Standards.

D. Waste Load Effects on Water Quality

Biochemical degradable waste impost a load on the dissolved oxygen recourses of a stream. Such a waste load is considered to have an effect upon water quality when they cause the dissolved oxygen (D.O.) concentration to drop below the Kentucky Water Quality Standard of 5.0 mg/l. Based on a model developed for the Kentucky Continuing Planning Process for River Basin Management Planning, 596 miles of streams in the basin that receive waste discharges were evaluated.. On the basis of present treatment levels and once on 10 year 7 day low flows the model shows 166 stream miles (28 per cent of the miles modeled) are affected by discharges.

The types of facilities affecting the streams and the length affected are 67 miles (11.2 per cent) by municipal discharges; 9.5 miles (1.7 per cent) by industrial discharges, and 89.5 miles (15 per cent) by other discharges. A miscellaneous discharge is one that is privately owned, eg. subdivisions, schools, etc. (See Table G-5)

E. Non-Point Source Effects

The primary non-point source of pollution in the Salt River is from soil erosion. The sediment pollution comes from field and stream bank erosion. In 1973 about 100 sq. mi. associated with agricultural crop land had high erosion rates and there are approximately 50 miles of streambanks that is a critical sediment source.

F. Water Uses in the Basin

Water uses in the basin are public and industrial, recreation, fish and wildlife, and agricultural. The total public and industrial usage in the Salt River Basin is 10 million gallons per day (m.g.d.) from surface water at 9.6 m.g.d. and groundwater at 0.4 m.g.d. The industrial usage is 5.5 m.g.d., (groundwater 0.1 m.g.d., surface water 5.4 m.g.d.) and the public usage is 4.5 m.g.d., (groundwater 0.4 m.g.d. and surface water 4.1 m.g.d.). Water withdrawal during periods of low flow is not a problem since during periods of low flow the water is withdrawn from reservoirs.

There are no large commercial water recreation sites in this basin.

It is generally understood that the Salt River Basin is good in sport fishing.

The Kentucky Department of Fish and Wildlife Resources is studying the sport fishing in this basin and a report will be published in the next two years.

G. Water Quality Changes

Sedimentation data that was collected in the period of 1948 to 1954 indicated that the Salt River Basin had the largest sediment load than any basin in Kentucky. The effects of agricultural runoff and logging operations in relation to the topography created a difficult control problem from these sources of sediment load. Continued effort by the U.S.D.A. SCS by encouraging proper soil utilization should assist in controlling the sediment load problem.

The problem associated with municipal waste discharge into Pond Creek and Floyds Fork will be corrected in a comparatively short time by intercepting the waste and conveying this waste to a treatment facility to be located on the Ohio River. Therefore, the expected changes in water quality are for improvement in both sediment load and from maintenance of D.O. levels at or above the level of the State-Federal Water Quality Standards.

III. Summary

The general chemical and trace water quality in Kentucky's Salt River Basin has been shown to be of high quality. There are problems, however, related to other aspects of water quality in the basin that require attention and action to be corrected. Severe soil erosion from farming practices presents a major problem with excessive sediment in the water. Treated wastes discharged from municipal, independent and industrial sources effect the water quality of the basin's streams. Upgrading the treatment facility and improvement in operation and maintenance of waste treatment facilities is needed. A program of operator licensing and education to improve operation and maintenance is a significant part of the Division of Water Quality operations.

TABLE G-2

Population in the Salt River Basin

County	City	Urban Population in Basin	Total Population in Basin	Area (sq. mi.)
Casey			4,150	94
Taylor			100	28
Larue			2,600	89
Hardin			49,000	140
	Fort Knox	37,608		
	Radcliff	7,881		
	Total	45,489		
Bullitt			26,090	300
	Mt. Washington	2,020		
Jefferson			323,000	220
	Louisville	79,919		
	Seneca Gardens	822		
	Strathmore	1,004		
	Jeffersontown	9,701		
	Fern Creek	6,000		
	Beuchel	9,000		
	Audubon Park	1,862		
	Newburg	4,000		
	Okolona	17,643		
	Prairie Village	3,000		
	Fairdale	2,500		
	Glengary	1,500		
	Valley	3,500		
	Medora	300		
	Total	166,882		
Oldham			5,750	64
	Crestwood	900		
	Pewee Valley	950		
		1,850		
Henry			1,087	14
	Pleasureville	747		
Shelby			15,900	314
	Shelbyville	4,182		
	Simpsonville	628		
	Veachland	700		
	Total	5,510		
Anderson			7,500	140
	Lawrenceburg	3,579		
	Stringtown	300		
		3,879		
Mercer			11,800	150
	Harrodsburg	6,741		
	Salvisa	350		
		7,091		

County	City		Urban Population in Basin	Total Population in Basin	Area (sq. mi.)
Boyle				4,600	100
	Mitchellsburg		500		
	Perryville		730		
		Total	1,230		
Marion				16,700	343
	Bradfordsville		338		
Nelson				23,480	437
	New Haven		977		
	Bardstown		5,816		
		Total	6,793		
Washington				10,730	307
	Loretto		985		
	Springfield		2,961		
			3,946		
Spencer				5,492	192
	Taylorsville		897		
		TOTAL	245,925	507,232	2,932

Source: 1970 U. S. Census as reported in the Rand McNally "Standard Reference Map and Guide of Kentucky"

TABLE G-3

Water Quality Data in the Salt River Basin
Data Presented was collected on the Salt River at Shepherdsville

Parameter	#Obs.	Mean	Standard Deviation	Max.	Min.	Beginning Date	Ending Date
1) pH specific units, Kentucky Standard is 6-9							
	39	7.8	0.5	8.5	6.9	11-65	4-74
2) Conductivity micro mhos, Kentucky Standard 800 micro mhos							
	49	400	80	540	170	11-65	6-74
3) Dissolved Solids mg/l (milligrams per liter), Kentucky Standard, 500 mg/l							
	5	210	100	320	98	3-69	4-74
4) Alkalinity mg/l, no standard							
	19	160	44	240	62	10-66	4-74
5) Hardness mg/l, 0-60 soft, 61-120 mod. hard, 121-180 hard, 181+ very hard							
	39	200	51	280	62	11-65	4-74
6) Fluoride mg/l, Kentucky Standard 1.0 mg/l							
	56	0.2	0.2	0.9	0.1	1-70	11-74
	22	0.3	0.3	0.9	0.1	1-73	11-74
7) Calcium mg/l, no standard							
	7	60	26	90	23	11-65	4-74
8) Magnesium mg/l, no standard							
	7	11	6.3	18	1.0	11-65	4-74
9) Lead ug/l, Kentucky Standard 50 micro-grams per liter (ug/l)							
	54	13	6	34	0	1-70	11-74
	22	14	5	25	0	1-73	11-74
10) Silver ug/l, Kentucky Standard 50 ug/l							
	54	0.78	0.5	2.0	0	1-70	11-74
	22	0.77	0.4	1.0	0	1-73	11-74
11) Arsenic ug/l, Kentucky Standard 50 ug/l							
	14	0.64	0.9	3.0	0	1-70	4-74
	6	0.33	0.5	1.0	0	1-73	4-74
12) Cadminum ug/l, Kentucky Standard 100 ug/l							
	55	1.2	0.8	4.0	0	1-70	11-74
	22	1.2	1.1	4.0	0	1-73	11-74
13) Chromium ug/l, Kentucky Standard 50 ug/l							
	55	1.4	1.2	5.0	0	1-70	11-74
	22	2.0	1.1	5.0	0	1-73	11-74

Water Quality Date in the Salt River Basin
Data Presented was collected on the Salt River at Shepherdsville

		#Obs.	Mean	Standard Deviation	Max.	Min.	Beginning Date	Ending Date
15)	Color	Platinum Cobalt Units						
		7	29	50	140	1	11-65	4-74
16)	Sodium	mg/l, no standard						
		7	6.1	2.1	8.9	2.0	11-65	4-74
		6	5.2	1.7	7.9	3.3	4-73	10-74
17)	Potassium	mg/l, no standard						
		7	2.6	.72	3.7	1.5	11-65	4-74
18)	Chloride	mg/l, prop. EPA Standard 250 mg/l						
		39	8.3	2.9	19	2.3	11-65	4-74
19)	Sulfate	mg/l, prop. EPA Standard 250 mg/l						
		39	34	9.0	48	10	11-65	4-74

TABLE G-4

Construction Grants in the Salt River Basin

COUNTY-CITY	POPULATION	TYPE OF GRANT	COMMENTS
Anderson			
Alton	160	II	Pending
Lawrenceburg	3,579	I	Underway
Bullitt			
Lebanon Junction	1,571	I	Pending
Henry			
Pleasureville	747	I	Pending
Jefferson			
Jeffersontown	9,701	I	Pending
Okolona	17,643	I	Pending
Marion			
Lebanon	5,528	I	Pending
Mercer			
Harrodsburg	6,741	I	Pending
Nelson			
Bardstown	5,816	I	Underway
Shelby			
Shelbyville	4,182	I	Underway
Simpsonville	628	I	Underway
Washington			
Springfield	2,761	I	Underway

NOTE: Project type is related to the type of grant applied for or received by each city. Type I is for preliminary studies necessary before design of the facility. Type II is the design phase of a facility and Type III is for the construction of a facility for the collection and treatment of domestic sewage.

The comments relate to the status of the grant. Underway indicates the project type is funded. Pending indicates that application for a grant has been made and is pending approval and no sewers means when a grant is requested that it is for a complete and original system.

The source of this information was the 1970 U. S. Census and the FY 75 construction grants list for Kentucky.

TABLE G-5

Organic Loads Affecting Streams in the Salt River Basin

Length of streams to which treated organic loads are discharges		596 miles
Stream length for which dissolved oxygen is predicted to be below 5 mg/l during periods of low flow		166 miles
Stream length for which dissolved oxygen is predicted to be below 5 mg/l during periods of low flow	Municipal Discharges	67 miles
	Industrial Discharges	9.5 miles
	Other Discharges	90 miles

NOTE: This information is from the waste load allocation for Kentucky and is an output from the 303e river basin planning effort. The values indicate the stream miles in which the dissolved oxygen is predicted to be less than 5 mg/l when the stream flow is less than the once in ten year seven day (Q_{10-7}) low flow.

THE KENTUCKY RIVER BASIN

This report is basically divided into two main sections, the first section being a description of the basin and the second section dealing with the quality of the water in the basin.

The first section is entitled "Basin Description" and describes the geography, topography, geology, hydrology and population characteristics within the Kentucky River Basin.

The second section of the report is entitled "Basin Water Quality" and describes the quality of the water with respect to general chemical, trace chemical, waste load effects, non-point source effects, uses, and changes.

I. A Description of the Kentucky River Basin

A. Geography

In an effort to better describe the Kentucky River Basin it will be divided into two sections. The first section (hereinafter referred to as the "Headwater Section") begins at the headwaters and ends at the City of Irvine and includes the three major forks of the river and 37 miles of its main stem. The remainder of the basin (hereinafter referred to as the "Bluegrass Section") will further be divided into inner and outer sections. The main stem of the Kentucky River is 255.5 miles long from it's mouth to the confluence of the North, Middle and South Forks.

The Kentucky River Basin lies wholly within the State of Kentucky and the river flows in a northwesterly direction. It begins in southeastern Kentucky, flows through the central part of the state and empties into the Ohio River at mile point 435.6 in North Central Kentucky.

The total area of the basin is 7,033 sq. mi. and contains eight sub-basins with areas of over two hundred sq. mi. (See Table H-1) The basin contains, either wholly or partially, 36 of the 120 counties in the State. (See Table H-2)

B. Topography

The Headwater Section is a mountainous area and is heavily mined for coal. Therefore, the water has a considerable sulfate content and is slightly acidic in the immediate coal mining areas. The average slope of the tributaries in this section ranges from 3 ft./mi. to 7.2 ft./mi. which are moderate slopes and it can therefore be said that the waste load assimulation capacity of the tributaries in this section is moderate. The average slope of the main stem of the river in this section is approximately 0.9 ft./mi. which is a low slope for reaeration.

The maximum elevations of the tributaries in this section range from 760 feet to 1,250 feet mean sea level (m.s.l.). It should be noted that water will hold about 2 per cent less dissolved oxygen for every 500 feet in elevation above sea level. Therefore, the dissolved oxygen capacity of these streams is retarded by approximately 4 per cent.

The Bluegrass Section lies in north-central Kentucky and is a structurally high but physiographically level area. The average slope of the tributaries in this section ranges from approximately 3 feet per mile to 32 feet per mile which are moderate to high and it can therefore be said that the waste load assimilation capacity of the tributaries in this section are moderate to high. The average slope of the main stem of the river in this section is approximately 0.7 ft./mi.

The maximum elevations of the tributaries in this section range from 710 feet to 950 feet m.s.l. and therefore the dissolved oxygen capacity of these streams is retarded by approximately 3 per cent. (For more detailed

information regarding slopes and elevations see Table H-3)

C. Geology

For the purposes of this report the most significant geological feature in the Headwater Section is the coal resources. Due to the mining activities including the stripping, washing, and loading of coal, there is a great amount of exposed coal in this area. The runoff is rapid and carries a considerable amount of solids to the streams. There are also thin beds of limestone in this area which contribute to the hardness of the water. Because of greater relief and the resulting more rapid runoff of surface water and drainage of groundwater from exposed strata, groundwater is not available in adequate amounts for water supply. Groundwater supplies diminish in dry weather owing to the paucity of groundwater storage.

The Bluegrass Section can be divided into inner and outer sections with regards to geology, the inner bluegrass being underlain by thick, pure limestone and the outer bluegrass by outward dipping thin beds of limestone and shale. The limestone of the inner bluegrass, though thick and soluble, contains shaly zones which are important because they limit the circulation of water and the development of permeable zones. In the outer bluegrass the conditions are even less favorable because the limestone beds are thinner and there is more inner bedded shale. Limestone that underlies shale will rarely yield much water except near streams that have cut through the shale. The only wells in bedrock that produce more than 100 gallons per minute are in thick limestone in the inner bluegrass. Nearly all successful wells in bedrock are less than 100 feet deep. In the bluegrass region as a whole the groundwater is hard to very hard. About one-eighth of the existing wells are reported to yield water containing excessive sodium and chloride, and about one-fifth yield water containing

noticeable amounts of hydrogen sulfide.

D. Hydrology

The Kentucky River has fourteen dams (See Table H-8) in it which restrict the flow and cause a decrease in reaeration rates, therefore causing the dissolved oxygen content to be reduced when an organic load is imposed on the stream. Furthermore, the slow moving water allows suspended solids to settle causing sludge deposits which impose a demand on dissolved oxygen and can hamper navigation unless removed.

There are two water withdrawals in the basin that are significant to water quality. The City of Lexington withdraws from the Kentucky River but discharges to tributaries which enter the river below Lock 8, and the City of Winchester withdraws from the Kentucky River but discharges to another basin. The City of Winchester withdraws approximately 1.5 MGD and the City of Lexington withdraws approximately 28 MGD. These two withdrawals are not put back in the river above Lock 8 near Frankfort and therefore reduce the once in seven day, ten year low flow at the Lock by the total 29,500,000 gallons per day or approximately by 20 per cent. This reduced low flow can affect the waste load allocation and subsequent treatment levels required for the cities of Richmond and Berea.

The City of Lawrenceburg also withdraws from the Kentucky River and discharges into another basin but this withdrawal has no significant impact on water quality.

The average normal flow of the Kentucky River at Locks 14, 10, and 4 are 3,583 cubic feet per second, 5,234 cubic feet per second, and 7,042 cubic feet per second respectively. The average yield of the basin is 1.33 cubic feet per second per square mile throughout the main stem of the river. The following table expands on these flow characteristics:

Table H-4

Surface Water Records for the Kentucky River Basin

Station	Period of Record	Drainage Area	Average Flow	Maximum Flow	Minimum Flow	7 day 10 yr. Low Flow
N. Fork of Ky. River at Hazard	34 yr.	466 sq. mi.	572 cfs, 1.2 cfs* / sq. mi.	47,800 cfs, 103 cfs / sq. mi.	Not Determined	93 cfs
Lock 14 near Heidelberg	42 yr.	2,657 sq. mi.	3,853 cfs, 1.4 cfs / sq. mi.	120,000 cfs, 45 cfs / sq. mi.	4.0 cfs, 0 cfs / sq. mi.	178 cfs
Lock 10 near Winchester	67 yr.	3,955 sq. mi.	5,233 cfs, 1.3 cfs / sq. mi.	92,400 cfs, 23 cfs / sq. mi.	10.0 cfs, 0 cfs / sq. mi.	181 cfs
Lock 4 near Frankfort	49 yr.	5,412 sq. mi.	7,042 cfs, 1.3 cfs / sq. mi.	115,000 cfs, 21 cfs / sq. mi.	Not Determined	281 cfs
Elkhorn Creek near Frankfort	37 yr.	473 sq. mi.	604 cfs, 1.3 cfs / sq. mi.	23, 200 cfs, 49 cfs / sq. mi.	0 cfs, 0 cfs / sq. mi.	28*cfs

* Cubic Feet Per Second

NOTE: Data is taken from "Surface Water Records in Kentucky" by the United States Geological Survey. The 7 day 10 year low flow was taken from the waste load allocation produced as a component of the 303e River Basin Continuing Planning Process. *from effluent from main Lexington Town Branch Plant 18 MGD (28 cfs)

There are fifteen lakes (See Table H-5) located in this basin with a total combined volume of 286,000 acre feet and a total combined surface are of 6,530 acres. The only lakes considered in the Kentucky basin report are those whose volume is greater than 1,000 acre feet or have a surface area greater than 100 acres. Two of these lakes, Buckhorn Lake and Carr Fork Lake, are Federal installations with a combined volume of 28,000 acre feet. The Buckhorn Lake (22,000 acre feet) is regulated to meet flood, recreation, fish and wildlife and low flow augmentation objectives. The low flow augmentation objective aides the stream below the lake during periods of low flow by means of dilution and reaeration. The Carr Fork Lake (6,000 acre feet) has not been in operation long enough to determine its effects upon the stream below it.

E. Population

The total population in the basin is 534,400 with the rural population being 291,200 or 55 per cent of the total population. There are forty-two incorporated cities in the basin representing the remaining 243,200 people. The major concentration of population is in the inner bluegrass region in the adjoining counties of Fayette, Madison, Franklin, Scott and Woodford. These five counties represent 283,900 people or 53 per cent of the total population in the basin. (See Table H-6)

II. Basin Water Quality

A. Description of Sampling Stations

The water quality data presented in the next two sections of this report was collected at five sampling stations. Two of these stations are located on the main stem of the river at Lock 4 near Frankfort and at the Lexington water treatment plant near I-75 in southern Fayette County. The other three stations are located on major tributaries thusly: North Fork of the Kentucky River at Hazard, Red River at Pine Ridge, and Eagle Creek at Glencoe. The total drainage area encompassed by these stations is 5,412 square miles with the station on the North Fork of the Kentucky River at Hazard having 466 square miles above it, the station on the Red River having 180 square miles above it, the station on the main stem at Lexington having 4,015 square miles above it, the station on Eagle Creek at Glencoe having 430 square miles above it, and the station on the main stem at Lock 4 having 5,412 square miles above it. The summary of the raw water quality data is in Table H-9.

The station on the North Fork at Hazard was purposely chosen to represent water quality data in a coal mining area. The other four stations are more indicative of the general water quality in the Kentucky River Basin.

B. General Chemical Water Quality

The chemical composition of water is best defined by grouping dissolved elements which compose the total dissolved solids. By examining the relationships of groups of chemicals, the type of water whether hard or soft, salty, acid or high in sulfates reflects the mix of surface and groundwater. The chemical characteristics of a stream when viewed over a long period of time is primarily from surface water. The type of rock formation and soils which the surface water contacts causes this predominate chemical characteristic. The

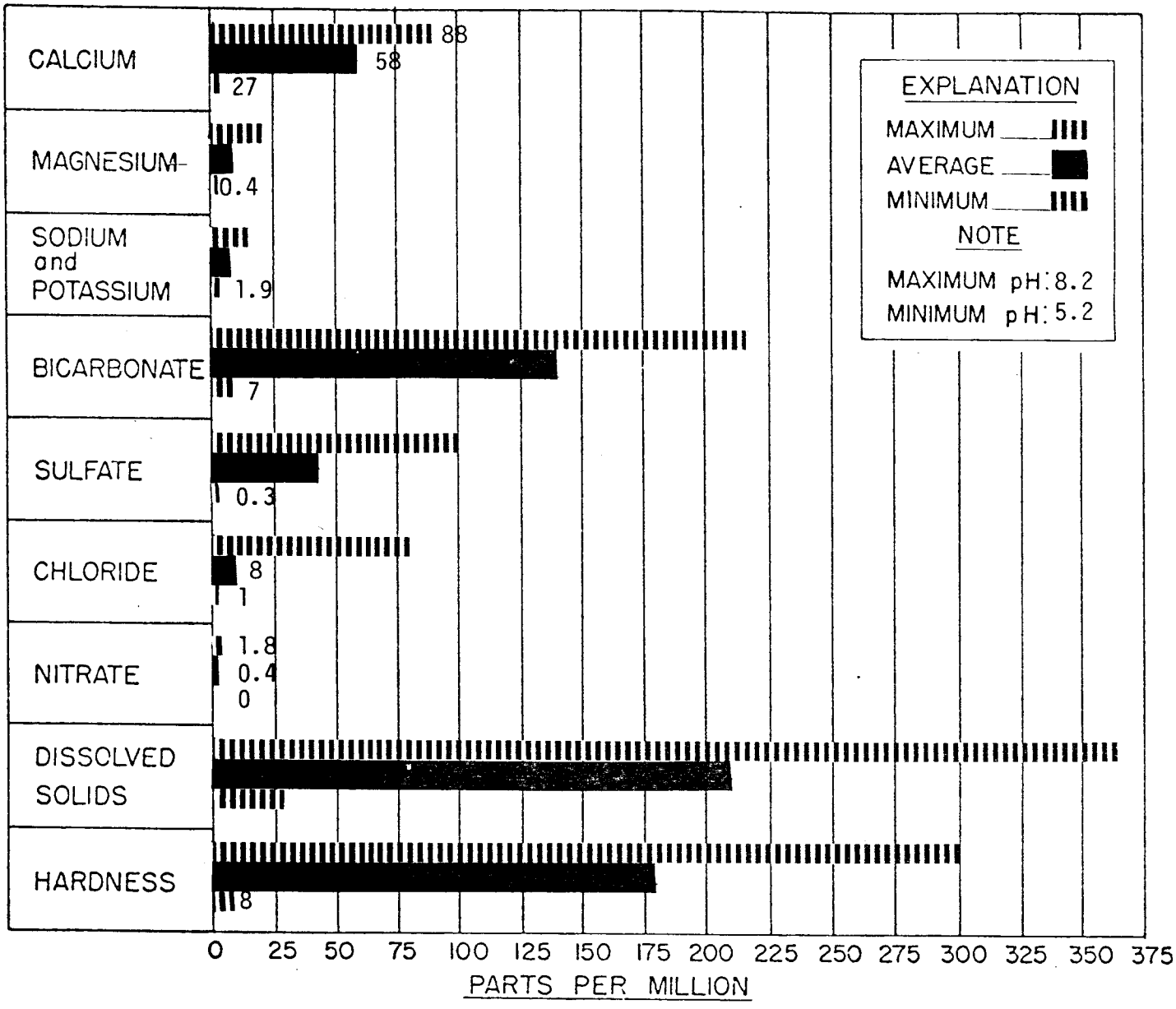
contribution of groundwater, which is generally higher in dissolved solids than surface water, can be shown by selecting the low flow period for data analyses. The general character of waters in Kentucky is one of moderate hardness caused by calcium and magnesium salts. The influence of mining activities are clearly indicated when the sulfate content increases to a higher level than the bicarbonate content, and the pH is on the acid side, below pH 5.5.

Oil field operations, when brine is encountered, are reflected by changes in sodium and chloride contents of the water. For Kentucky water, the influence is pronounced when either chloride or sodium exceeds 20 - 25 parts per million as an average value.

The overall water quality for the Kentucky River Basin is represented by the stations at Lock 4 near Frankfort, Red River at Pine Ridge, and Eagle Creek at Glencoe. The two remote stations in the basin are Eagle Creek at Glencoe and the Red River at Pine Ridge and both demonstrate the water quality for a sensitive stream. This means that water quality parameters have a wide range with respect to the average value.

Reference is made to Figures H-1 and H-2 which represent data for Eagle Creek at Glencoe for the period of record and for data collected since January 1, 1973, respectively. Water quality at Eagle Creek at Glencoe indicates that the water is very hard meaning that the calcium carbonate hardness is greater than 180 mg/l. Water in this sub-basin tends to be periodically acidic. The data indicates that the bicarbonate alkalinity is high providing a good inorganic load buffering capacity in this particular stream. The overall water quality in this sub-basin is good.

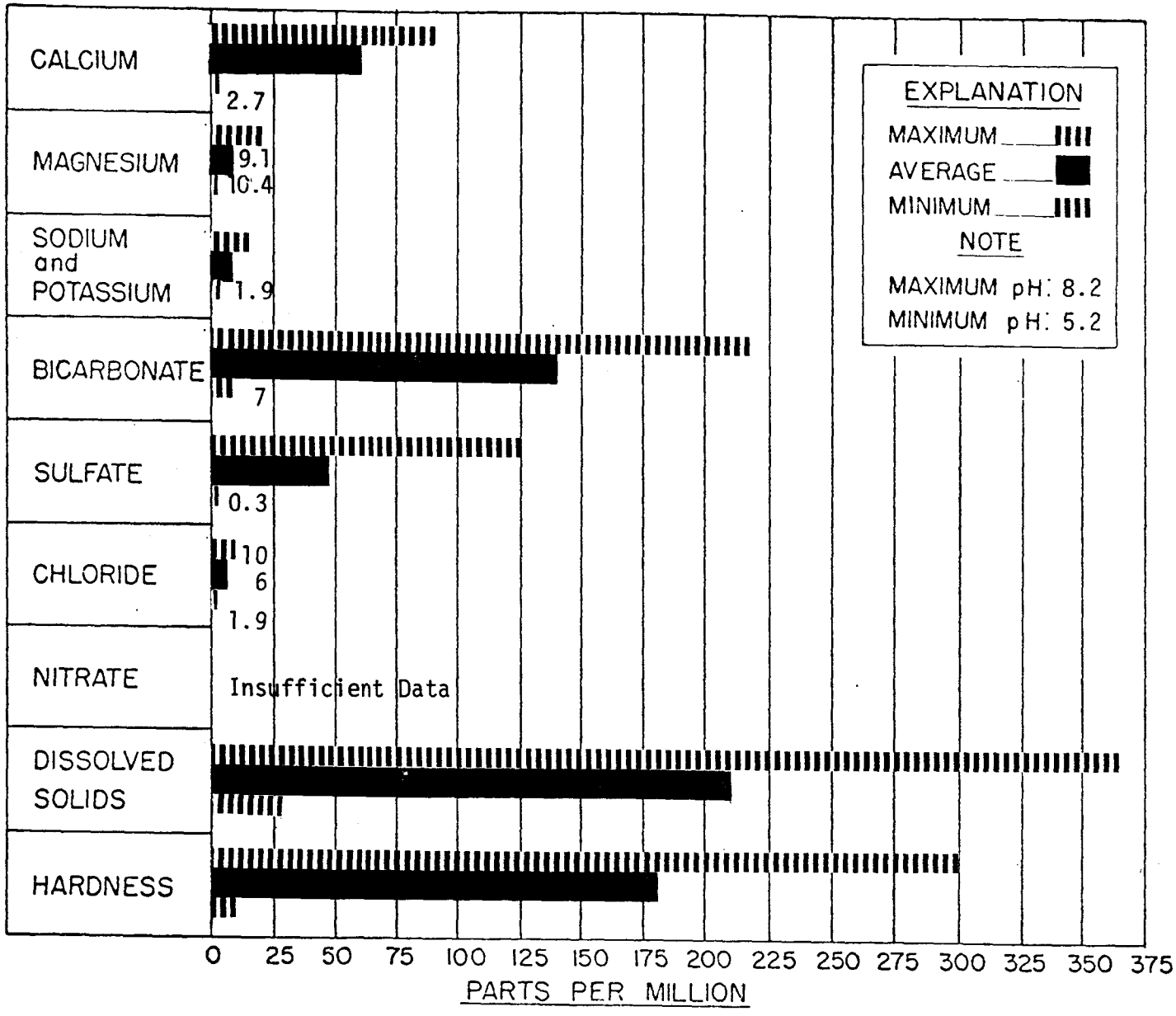
Relative to the Eagle Creek basin, the water quality in the Red River at Pine Ridge has a higher quality as demonstrated by Figures H-3 and H-4. This is indicated by water characterized as soft (calcium carbonate hardness



MAXIMUM, AVERAGE, and MINIMUM concentrations of dissolved constituents,

Eagle Creek at Glencoe
Period of Record 7-62 to 11-74

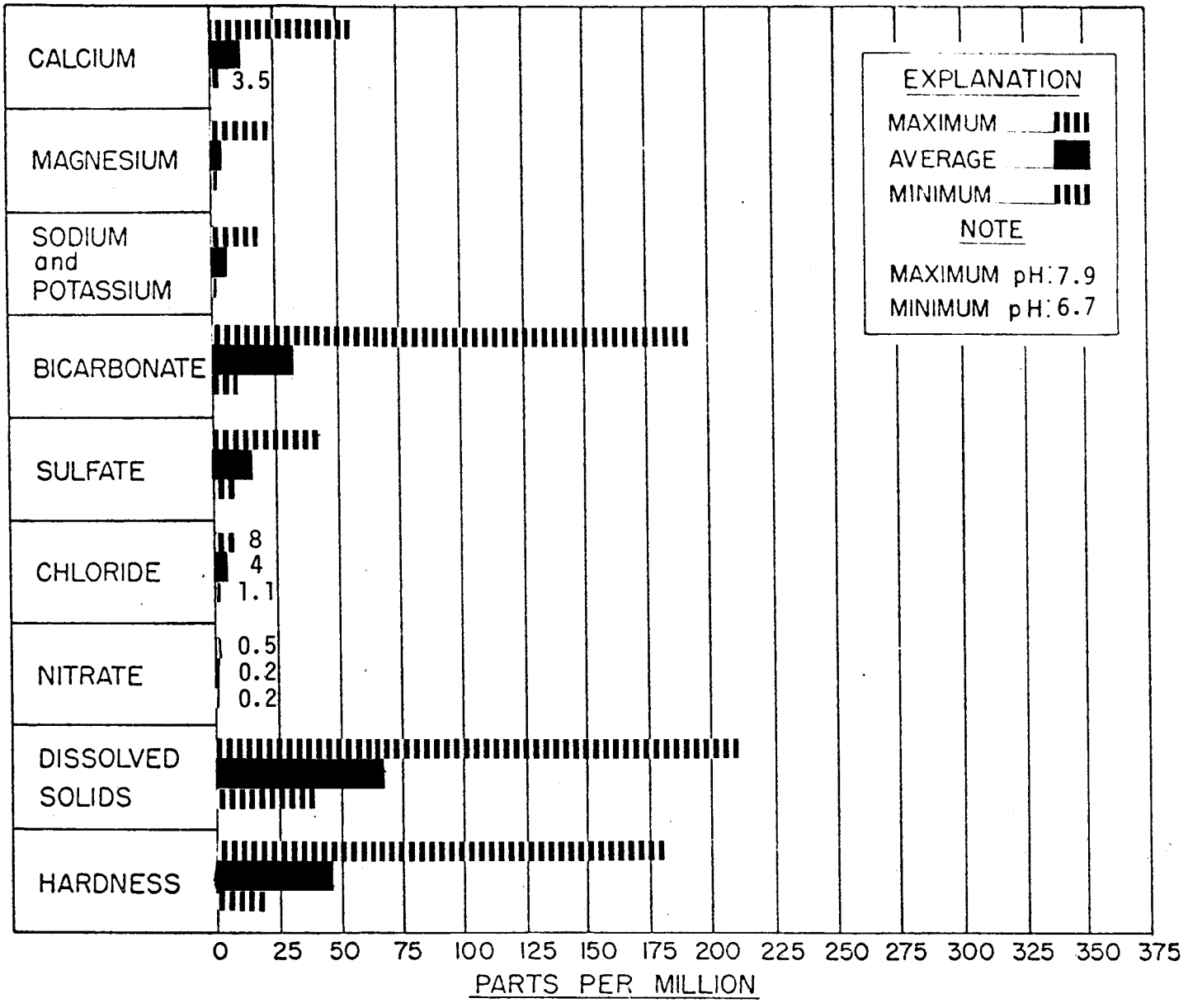
Figure H-1



MAXIMUM, AVERAGE, and MINIMUM concentrations of dissolved constituents,

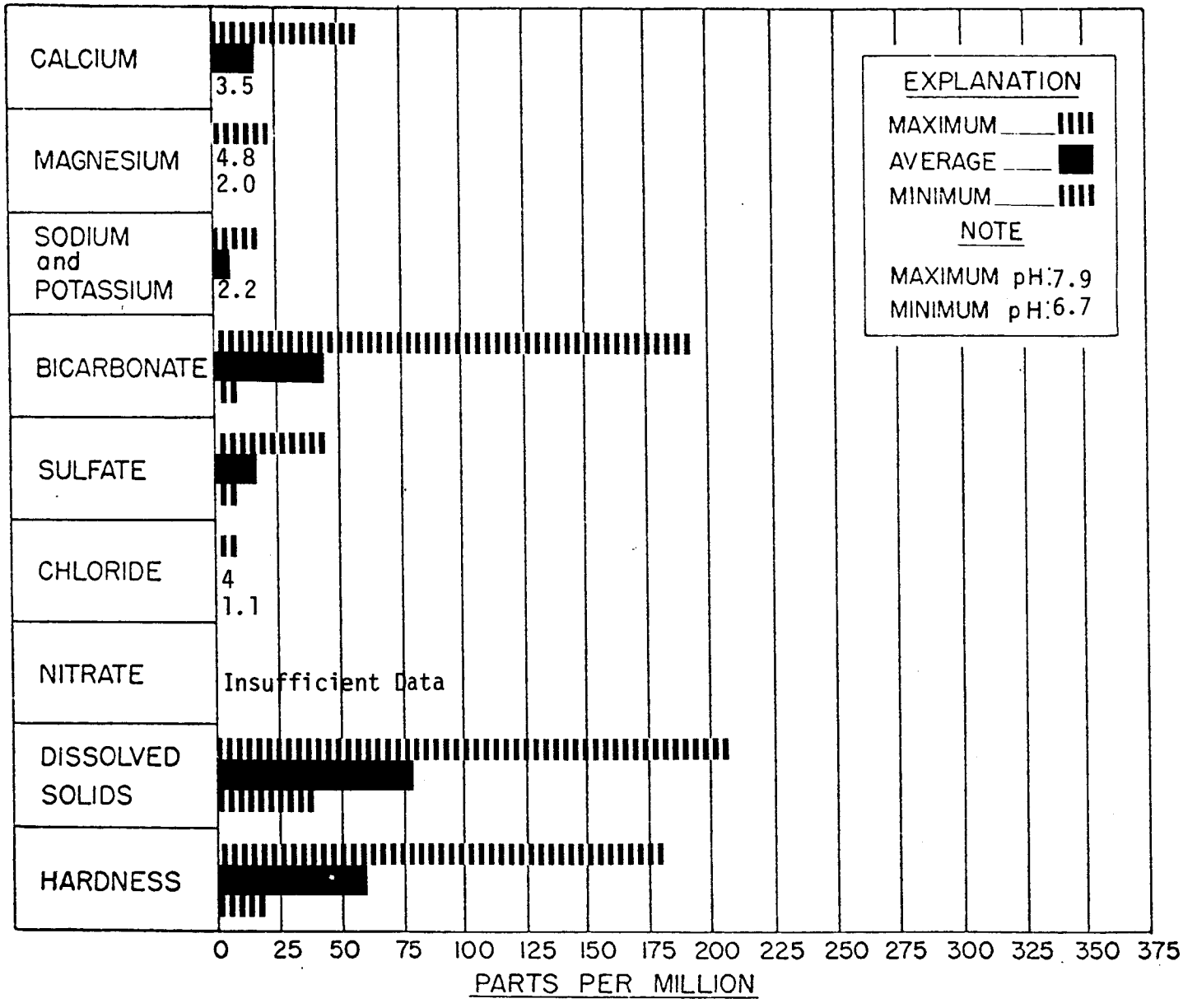
Eagle Creek at Glencoe

Period of Record 2-73 to 11-74



MAXIMUM, AVERAGE, and MINIMUM concentrations of dissolved constituents,

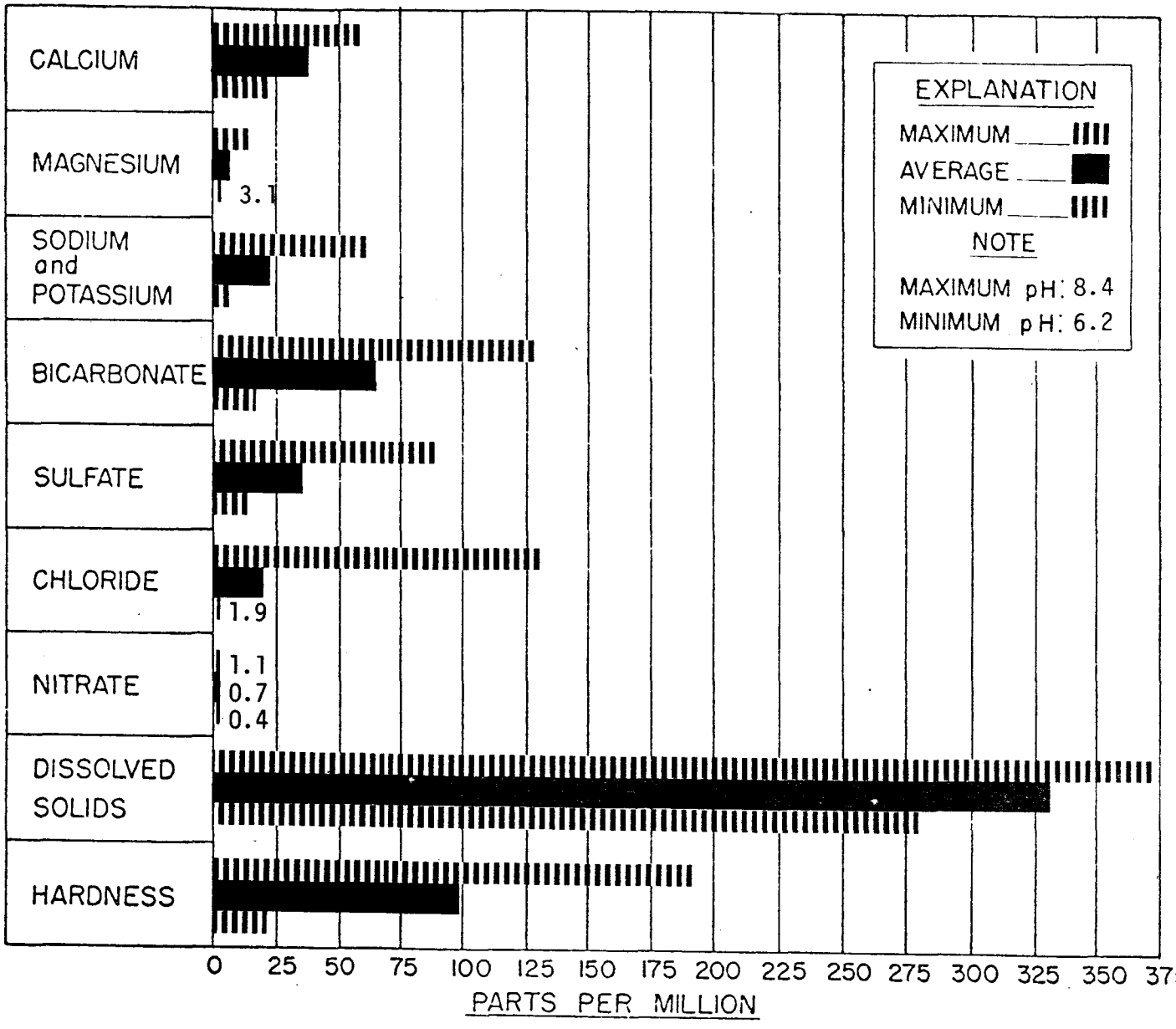
Red River at Pine Ridge
Period of Record 4-69 to 11-74



MAXIMUM, AVERAGE, and MINIMUM concentrations of dissolved constituents,

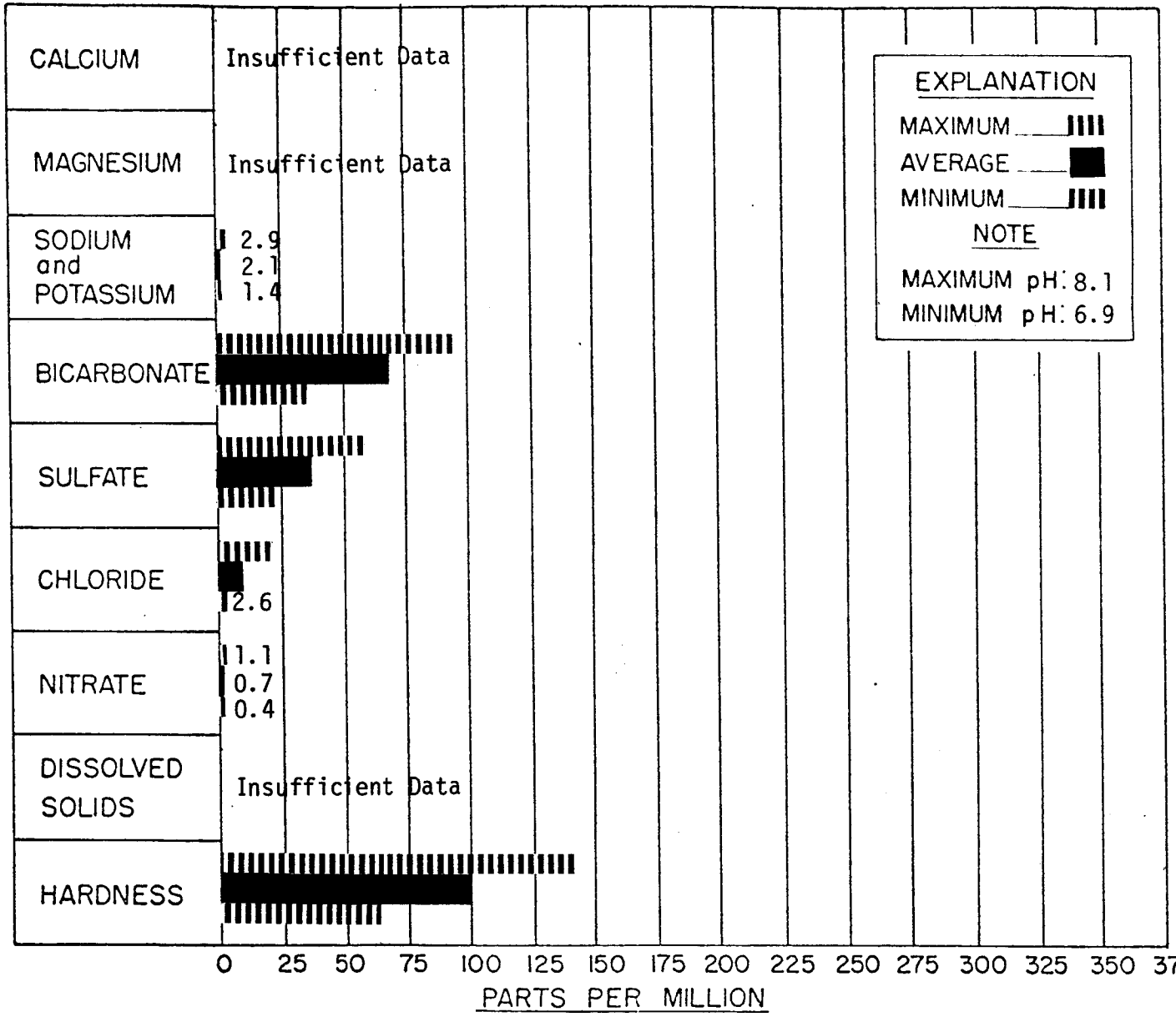
Red River at Pine Ridge
Period of Record 1-73 to 11-74

Figure H-4



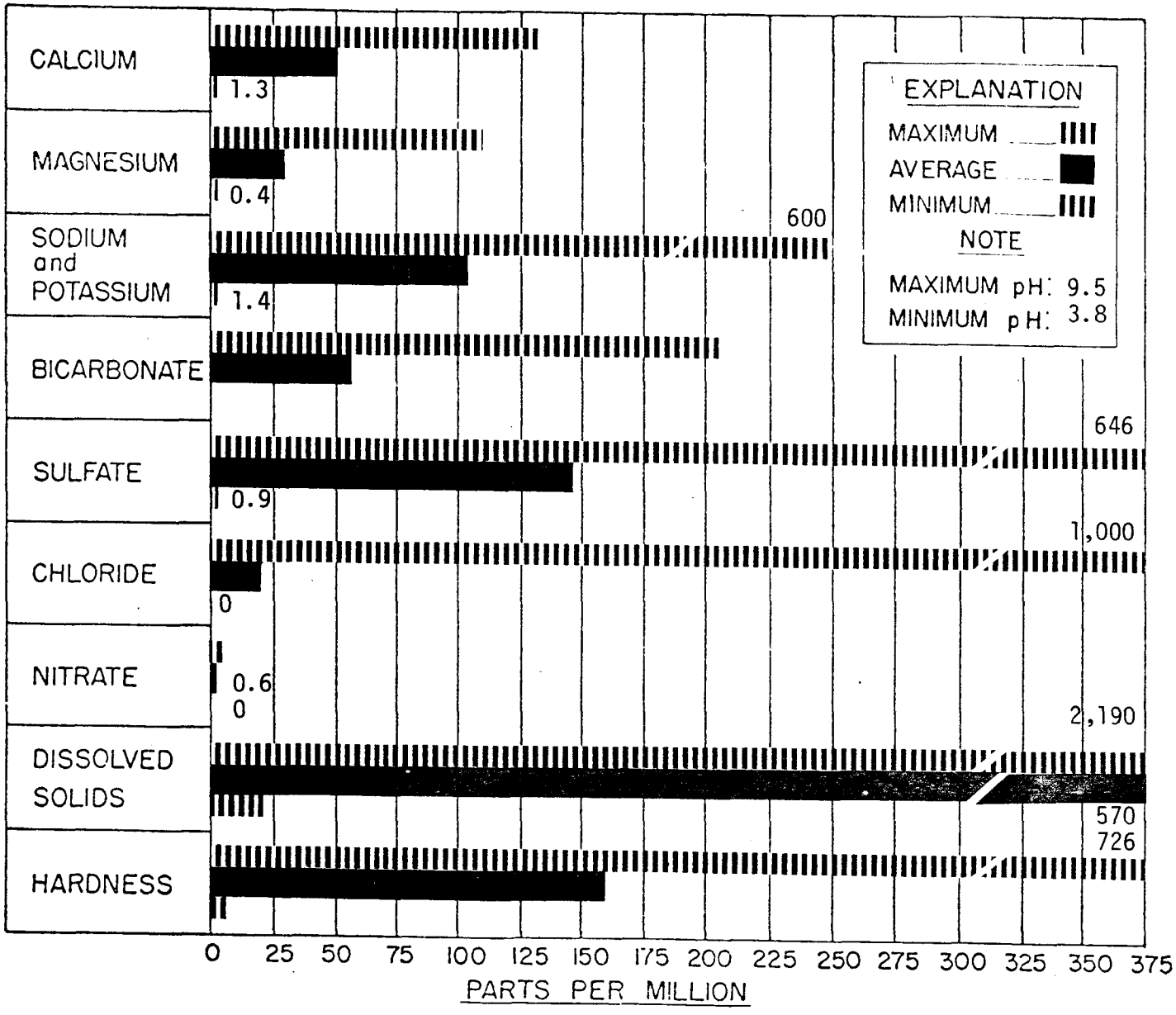
MAXIMUM, AVERAGE, and MINIMUM concentrations of dissolved constituents,
Kentucky River, Lock 4 at Frankfort
Period of Record 10-59 to 9-73

Figure H-5



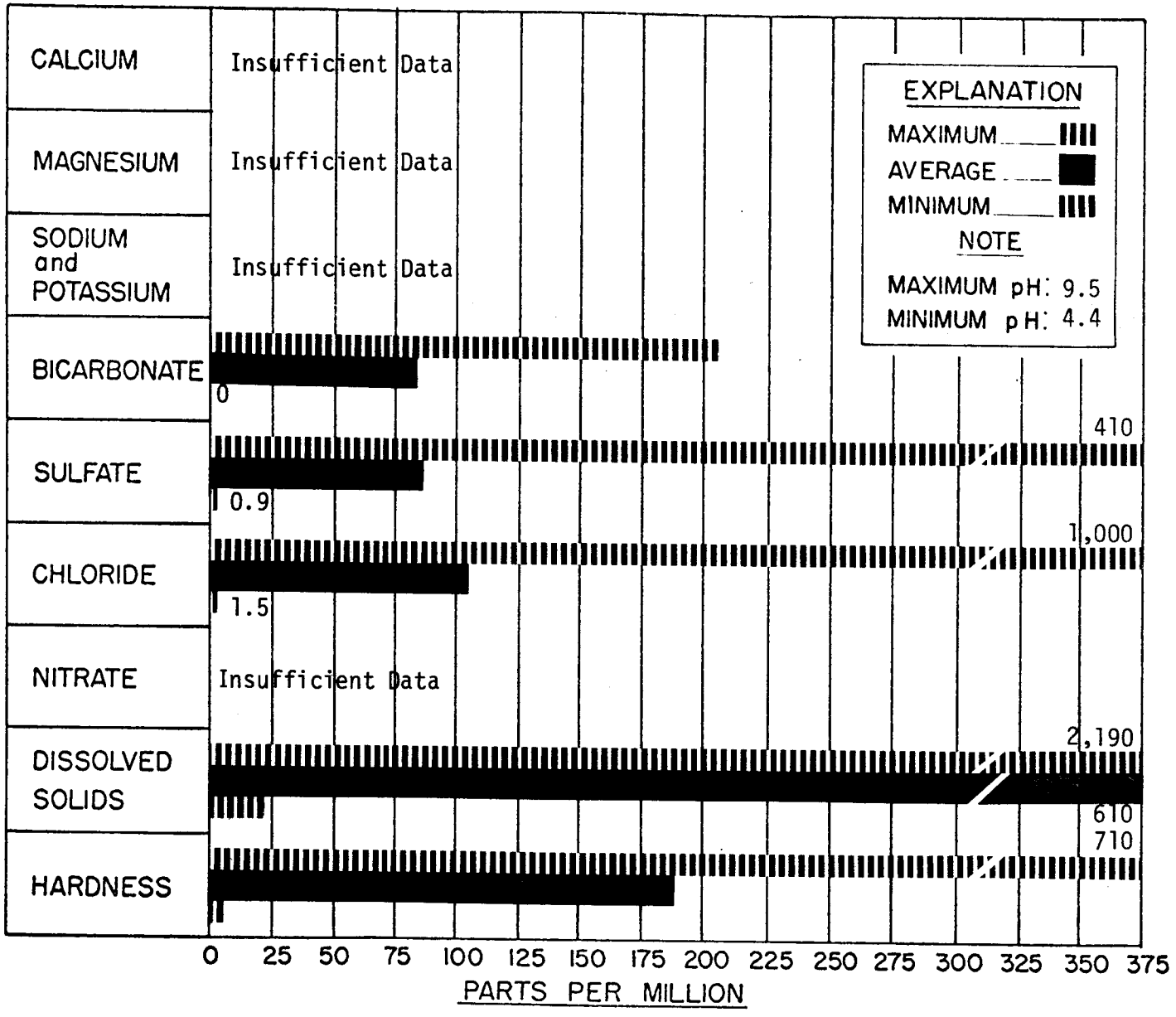
MAXIMUM, AVERAGE, and MINIMUM concentrations of dissolved constituents,

Kentucky River, Lock 4 at Frankfort
Period of Record 1-73 to 11-74



MAXIMUM, AVERAGE, and MINIMUM concentrations of dissolved constituents,

N. Fork Kentucky R. at Hazard
Period or Record 10-62 to 6-74



MAXIMUM, AVERAGE, and MINIMUM concentrations of dissolved constituents,

North Fork Ky. River at Hazard
Period of Record 1-73 to 6-74

Figure H-8

of less than 60 mg/l). The data studied indicates that the water in the Red River sub-basin is of the highest quality throughout the entire Kentucky River Basin.

The water quality of the main stem of the Kentucky River is demonstrated in Figures H-5 and H-6. This data was collected at Lock 4 near Frankfort and the river at this point is relatively insensitive due to its large drainage basin representation. This means that large influences are required to change the values measured in water quality. This data shows influences from upstream activities by an increase in dissolved solids and an increase in the hardness of the water. The hardness in the main stem is characterized as moderately hard (calcium bicarbonate hardness of 60 - 120 mg/l).

The North Fork of the Kentucky River at Hazard is just downstream of an intensive coal mining area and demonstrates the effects of such on water quality as can be seen in Figures H-7 and H-8. The North Fork is a relatively sensitive station showing a more rapid change in water quality. The water quality has been degraded by an increase in dissolved solids, hardness, sulfate, magnesium, calcium, sodium and potassium. The chloride levels are high as well as the sodium and potassium levels. This can be attributed to materials related to the coal mining industry. The acidity has increased as demonstrated by a decrease in pH. In general the water quality at this station is regarded as poor.

C. Trace Chemical Water Quality

Trace elements (under 5 mg/l) are separated from the general chemical background of this report because of their influence on human health. Generally, these materials are "heavy" metals, which in sufficient concentrations have a toxic or otherwise adverse effect on human and animal or plant life. Levels for many of these elements have been established for years in the Drinking Water Standards and more recently through the State-Federal Water Quality Standards.

The trace elements measured in the Kentucky River Basin were less than the Kentucky/FederalStandards for Drinking Water with the following exceptions. The station on the North Fork at Hazard yielded data that exceeded Kentucky/ Federal Water Quality Standards in the parameters of iron, manganese, and fluoride. These parameters can be directly or indirectly related to coal mining activities. A point of interest is that 128 million tons of coal were produced in Kentucky in 1973 and it is estimated that by 1985 this production level will reach 400 million tons in Kentucky or over three times that produced in 1973.

D. Waste Load Effects on Water Quality

Within the confines of this report, water quality is considered as affected when the dissolved oxygen concentration drops below 5 mg/l. Approximately 868 miles of stream length were studied under a model used to determine waste load allocations, developed in the Kentucky Continuing Planning Process for River Basin Management Planning. According to this data, approximately 150 miles of that stream length would have a dissolved oxygen concentration of less than 5 mg/l when the flow is equal to or less than the 10 year 7 day low flow. This is highly possible as the flow of many of the tributaries does drop to or below, the 10 year 7 day low flow. It is not predicted that the dissolved oxygen concentration in any segment of the main stem of the river will drop below 5 mg/l.

Of the 150 miles of stream length affected, approximately 124 miles or 83 per cent will be due to municipalities, and 26 miles due to other dischargers such as subdivisions, trailer parks, schools, etc. The waste loads causing this effect totaled approximate 32 million gallons per day (mgd) of discharges with 30 million of it contributed by municipalities and the remaining two million by other discharges.

E. Non-Point Source Effects

Non-point source effects can be summarized in the three categories of agriculture, mining and surface runoff. It is estimated that approximately 1,070 square miles of disturbed forest land, cropland, and field gullies and some 1,700 miles of streambank and roadbank erode excessively and contribute to sediment in the streams. It is further estimated that over 54 square miles of surface mined land is exposed and has an excessive erosion rate.

Surface runoff from urban areas is also a problem in cases where sizable cities are located on low flow streams. There are three such cases in the Kentucky River Basin at the cities of Lexington, Richmond and Danville. This type of source exerts a load on the receiving stream with respect to Biochemical Oxygen Demand (BOD) and suspended solids.

F. Water Uses

The most important use of water is for public water supply. Over 51 million gallons per day is withdrawn for use in this basin. Of this amount, approximately 24 million gallons per day or 48 per cent is used for public supply. The remaining 27 million gallons per day is used for industry. It should be noted that 27 percent, or fourteen million gallons per day, of the total withdrawal is withdrawn from groundwater.

Another major use of water in this basin is for recreational purposes. There are numerous boat docks, camp sites, beaches and other recreational facilities located in the Kentucky River Basin. Furthermore, according to the Kentucky Department of Fish and Wildlife, there are over 2,000 miles of stream in this basin capable of providing a sport fishery with a grand total of 99 species of fishes representing 18 families.

Generally, water in the basin is widely used in the agricultural industry primarily for livestock watering with a small amount used for irrigation. The water in the basin is of sufficient quality for this use

except in areas of extensive coal mining, i.e., in the headwaters.

G. Water Quality Changes

In general, the quality of the water in the Kentucky River Basin is not changing according to the data studied. However, the data taken at the station on the North Fork of the Kentucky River at Hazard reveals that the quality of the water is deteriorating. The concentrations of no less than nine of the parameters studied have increased by considerable amounts. With the energy crisis demanding greater and greater amounts of coal, there is the potential for these problems to increase even more. Much care must be taken in this area to prevent the quality of the water from deteriorating as coal production increases and an effort must be made to upgrade the existing quality of the water.

III. Summary

As stated earlier in this report, the quality of the water in the Kentucky River Basin is good at the station on the main stem of the river at Lock 4 near Frankfort, on the Red River at Pine Ridge and on Eagle Creek at Glencoe. However, the station on the North Fork of the Kentucky River at Hazard reflects the effects of coal mining on water quality.

The two main problems in the basin with regards to water quality are siltation and municipal organic wasteloads.

The problem of municipal organic wasteloads is twofold: Inadequate treatment facilities and improper operation of some existing treatment facilities. More emphasis should be placed on the training of wastewater treatment plant operators and recruiting of better qualified personnel to insure proper operation and maintenance of treatment facilities. According to the data, 38 per cent of the existing treatment facilities in this basin need improvements as they are affecting the quality of the water. It should also be noted that 19 per cent of the incorporated cities in the basin presently have no sewers.

The siltation and organic load problems related to urban runoff from sizable cities located on low-flow streams can be improved by the installation or upgrading of storm sewer systems.

The siltation problem related to coal production is localized in the headwaters. The coal producing counties that contribute to this basin are Bell, Clay, Estill, Harlan, Knott, Knox, Leslie, Letcher and Perry. The logging of forest land in preparation for strip mining can result in high runoff rates and serious erosion while the actual strip mining leads to sedimentation from upheval of surface soil. With today's emphasis on increased coal production, this problem will have to be controlled to prevent further degradation of the

water quality. As shown earlier in this report, the quality of the water is already below acceptable standards in this area and measures for improvement need to be emphasized and implemented.

The water quality problems related to coal production cannot be over emphasized. The State of Kentucky is the largest coal producing state in the nation and its production level is predicted to triple within the next few years. This amount of coal mining activity could have a disasterous, practically irreversible effect on the quality of the waters of Kentucky.